

02/23/00
jc714 U.S. PTO

LAW OFFICES
SUGHRUE, MION, ZINN, MACPEAK & SEAS, PLLC
2100 PENNSYLVANIA AVENUE, N.W.
WASHINGTON, DC 20037-3213
TELEPHONE (202) 293-7060
FACSIMILE (202) 293-7860
www.sughrue.com

JC678 U.S. PTO
09/511898
02/23/00

February 23, 2000

BOX PATENT APPLICATION

Assistant Commissioner for Patents
Washington, D.C. 20231

Re: Application of Hisashi YAMAGISHI, Hiroshi HIGUCHI, Junji HAYASHI,
and Akira KAWATA
MULTI-PIECE SOLID GOLF BALL
Our Ref: Q58044

Dear Sir:

This is a request for a Continuation-In-Part Application of pending prior Application No. 09/129,883 filed August 6, 1998, of Hisashi YAMAGISHI, Hiroshi HIGUCHI, Junji HAYASHI, and Akira KAWATA entitled, "MULTI-PIECE SOLID GOLF BALL."

Attached hereto is the Continuation-In-Part Application including the specification, claims and abstract, 2 sheets of formal drawings, the executed Declaration and Power of Attorney, the executed Assignment and PTO 1595 form, a PTO form 1449, and a Preliminary Amendment.

Priority is claimed from August 11, 1997 based on Japanese Application No. 9-228902. The priority document was filed in parent Application No. 09/129,883.

The Government filing fee is calculated as follows:

Total claims	3	-	20	=		x	\$18.00	=	\$0.00
Independent claims	1	-	3	=		x	\$78.00	=	\$0.00
Base Fee									\$690.00

TOTAL FILING FEE

Recordation of Assignment

TOTAL FEE

\$690.00

\$ 40.00

\$730.00

Checks for the statutory filing fee of **\$690.00** and Assignment recordation fee of **\$40.00** are attached. You are also directed and authorized to charge or credit any difference or overpayment to Deposit Account No. 19-4880. The Commissioner is hereby authorized to charge any fees under 37 C.F.R. §§ 1.16 and 1.17 and any

SUGHRUE, MION, ZINN, MACPEAK & SEAS, PLLC

Assistant Commissioner
for Patents

petitions for extension of time under 37 C.F.R. § 1.136 which may be required during the entire pendency of the application to Deposit Account No. 19-4880. A **duplicate** copy of this transmittal letter is attached.

The application is timely filed.

Respectfully submitted,

SUGHRUE, MION, ZINN,
MACPEAK & SEAS, PLLC
Attorneys for Applicant

By: Neil B. Siegel

Neil B. Siegel

Registration No. 25,200

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

Hisashi YAMAGISHI, et al.

Appln. No.: CIP of USSN 09/129,883

Filed: February 23, 2000

For: MULTI-PIECE SOLID GOLF BALL

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination, please amend the above-identified application as follows:

IN THE CLAIMS:

Please amend claim 3 as follows:

Claim 3, line 1, delete "or 2".

REMARKS

The application has been amended to remove the multiple dependencies, avoid the government surcharge and place the application in better form for examination. A favorable action on the merits is respectfully requested.

Respectfully submitted,



Neil B. Siegel
Registration No. 25,200

SUGHRUE, MION, ZINN,
MACPEAK & SEAS, PLLC
2100 Pennsylvania Avenue, N.W.
Washington, D.C. 20037-3213
Telephone: (202) 293-7060
Facsimile: (202) 293-7860

Date Filed: February 23, 2000

TITLE OF THE INVENTION
Multi-Piece Solid Golf Ball

5 CROSS REFERENCE TO RELATED APPLICATION

This application is an application filed under 35 U.S.C. §111(a) claiming benefit pursuant to 35 U.S.C. §119(e)(i) of the filing date of the Provisional Application 60/058,563 filed on September 11, 1997 pursuant to 35 U.S.C. §111(b).

10 This application is a continuation-in-part of copending application Serial No. 09/129,883 filed on August 6, 1998, the entire contents of which are hereby incorporated by reference.

15 BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to a multi-piece solid golf ball having a cover of inner and outer layers and more particularly, to a multi-piece solid golf ball in which cover hardness and dimples are optimized so as to improve flight distance performance.

Prior Art

25 Golf balls are generally classified into solid golf balls in which a solid core is enclosed with at least one layer of cover and wound golf balls in which a wound core in the form of a center ball having thread rubber wound thereon is enclosed with a cover. Numerous modifications were
30 heretofore proposed to improve flight distance properties, spin performance, and controllability.

As one example of such proposals, an approach of increasing a spin rate by forming the cover soft or to low hardness falls under the category of the prior art. In particular, improvements in multi-piece solid golf balls are by adjusting the composition and hardness of the thermoplastic resin of which each cover layer is constructed. For example,

-2-

if it is desired to increase a spin rate, the outer cover layer coming in direct contact with the club face is formed relatively soft in consideration of a friction phenomenon upon impact. Inversely, if it is desired to decrease a spin rate, the outer cover layer is formed relatively hard.

However, the multi-piece solid golf balls wherein the outer cover layer is formed relatively soft have the problem that a desired spin rate is not always obtained because the hardness of the inner cover layer in contact with the outer cover layer is not optimized and thus, the deformation process upon impact differs among the respective layers.

Also proposed were techniques of forming the inner cover layer relatively soft in order to increase a spin rate and forming the outer and inner cover layers relatively soft in order to further increase a spin rate. There arises the problem that the trajectory changes in flight to adversely affect the flight distance.

On the other hand, for those golf balls required to have flight distance performance, it is difficult to form dimples suitable for the spin range and restitution which vary with the cover hardness. Golf balls with dimples of one type suffer from the problem that they rise too high or drop to detract from the flight distance performance.

SUMMARY OF THE INVENTION

The present invention has been made under the above-mentioned circumstances and its object is to provide a golf ball comprising a solid core enclosed with two inner and outer layers enabling to increase a flight distance.

Making extensive investigations to achieve the above object, we have found in connection with a multi-piece solid golf ball comprising a solid core and a cover of two inner and outer layers surrounding the core, the outer cover layer being formed in the surface with a plurality of dimples, that a spin rate is approximately explained in terms of a product of the Shore D hardness of the inner cover layer multiplied by the Shore D hardness of the outer cover layer.

00544000-023400

-3-

More particularly, a more spin rate is obtained when the product of the Shore D hardnesses of the inner and outer layers has a relatively smaller value. Inversely, a less spin rate is obtained when the same product has a relatively larger value. Accordingly, effective means for taking full advantage of the spin property dependent on the product of the Shore D hardnesses of the inner and outer layers and improving the flight performance of the golf ball is to divide the range of the product into sub-ranges and form dimples so as to satisfy the following two requirements associated with the sub-ranges of the product. More particularly, it has been found effective as a first requirement to specify a proportion V_R (%) of the total of the volumes of dimple spaces each defined below a plane circumscribed by the dimple edge to the overall volume of a phantom sphere given on the assumption that the golf ball surface is free of dimples, and as a second requirement to form at least three types of dimples which are different in at least one of a diameter, a depth, and a value V_0 which is the volume of one dimple space defined below a plane circumscribed by the dimple edge divided by the volume of a cylinder whose bottom is the plane and whose height is the maximum depth of the dimple from the bottom. We have also found that to specify the distortion of the solid core and to specify the Shore D hardness of the inner and outer cover layers are more effective. The present invention is predicated on this finding.

Specifically, the present invention provides:

- 1) A multi-piece solid golf ball comprising a solid core and a cover of two inner and outer layers surrounding the core, the outer cover layer having a surface formed with a plurality of dimples, characterized in that

a product of the Shore D hardness of said inner cover layer multiplied by the Shore D hardness of said outer cover layer and a proportion V_R (%) of the total of the volumes of dimple spaces each defined below a plane circumscribed by the dimple edge to the overall volume of a phantom sphere

00544000.023400

given on the assumption that the golf ball surface is free of dimples satisfy any one of the following combinations (1) to (5):

- (1) the product of Shore D hardnesses of inner and outer
5 cover layers: 1,500 to less than 2,000

V_R : 0.80 to 0.95%

- (2) the product of Shore D hardnesses of inner and outer cover layers: 2,000 to less than 2,500

V_R : 0.75 to 0.95%

- 10 (3) the product of Shore D hardnesses of inner and outer
cover layers: 2,500 to less than 3,000

V_R : 0.70 to 0.95%

- (4) the product of Shore D hardnesses of inner and outer cover layers: 3,000 to less than 3,500

- 15 V_R : 0.65 to 0.95%

- (5) the product of Shore D hardnesses of inner and outer cover layers: 3,500 to 4,000

V_R : 0.60 to 0.90%,

and said dimples include at least three types of dimples which are different in at least one of a diameter, a depth, and a value V_0 which is the volume of one dimple space defined below a plane circumscribed by the dimple edge divided by the volume of a cylinder whose bottom is the plane and whose height is the maximum depth of the dimple from the bottom.

- 2) The multi-piece solid golf ball of 1) wherein the solid core has a distortion of 2.6 to 6.5 mm under an applied load of 100 kg.

- 3) The multi-piece solid golf ball of 1) or 2) wherein
30 both the hardnesses of the inner and outer cover layers are
up to 63 in Shore D hardness.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of a dimple
35 illustrating how to calculate a value V_0 .

FIG. 2 is a perspective view of the dimple illustrating how to calculate a value V_0 .

FIG. 3 is a cross-sectional view of the dimple illustrating how to calculate a value V_0 .

DETAILED DESCRIPTION OF THE INVENTION

5 Now the invention is described in more detail. The multi-piece solid golf ball of the invention is defined as comprising a solid core and a cover of two inner and outer layers surrounding the core, the outer cover layer having a surface formed with a plurality of dimples. When the range
10 of the product of the Shore D hardnesses of the inner and outer cover layers is divided into sub-ranges, a dimple parameter can be specified in conjunction with each of the sub-ranges of the product for achieving optimization.

First, the solid core is described. The solid core may be formed of a well-known rubber composition. For example, it is prepared by mixing 1,4-cis-polybutadiene as a base with a well-known crosslinking agent, co-crosslinking agent, filler and so on in a roll mill, introducing a necessary amount of the composition into a solid core-shaping mold, and effecting vulcanization and heat molding. In this regard, the solid core may consist of a single layer or plural layers. In the practice of the invention, the solid core preferably undergoes a distortion or deformation of 2.6 to 6.5 mm, more preferably 2.7 to 6.3 mm, most preferably 2.8 to 6.0 mm under an applied load of 100 kg. A distortion of less than 2.6 mm (hard core) would exacerbate hitting feel. A distortion of more than 6.5 mm (soft core) would result in a ball with less restitution.

The golf ball of the invention is constructed by forming a cover of two (inner and outer) layer structure around the aforementioned solid core. The inner and outer layers may be formed of well-known cover stocks. Specifically, ionomer resins, thermoplastic polyester elastomers, and thermoplastic polyurethane elastomers may be used alone or in admixture of two or more. In the practice of the invention, cover stocks must be selected such that the product of the Shore D hardness of the inner cover layer

multiplied by the Shore D hardness of the outer cover layer fall in the range of 1,500 to 4,000.

The Shore D hardnesses of the inner and outer cover layers may be identical with or different from each other insofar as the product of Shore D hardnesses falls in the range of 1,500 to 4,000. That is, the Shore D hardness of the inner cover layer may be substantially identical with the Shore D hardness of the outer cover layer. Alternatively, either one of the inner and outer cover layers may be softer or harder than the other. The hardness difference between the inner and outer cover layers may be appropriately determined.

Preferably the outer cover layer has a Shore D hardness of up to 63, more preferably 30 to 62, especially 35 to 61. With a Shore D hardness of more than 63, there is a risk that no spin is acquired due to a slip phenomenon between the cover and the club face. If the hardness of the outer cover layer is below 30, the ball would lose restitution.

On the other hand, the inner cover layer preferably has a Shore D hardness of 28 to 68. Restitution would be lost with an inner cover layer hardness of less than 28 whereas hitting feel would be exacerbated by a hardness above 68.

The method for forming the inner and outer cover layers around the solid core is not critical and can be in accord with conventional ones. Included are a method of enclosing the solid core with a pair of hemispherical half cups of an inner cover layer composition, compression molding to join the cups to the core, placing it in an injection mold, and injecting an outer cover layer composition and another method of forming half cups from inner and outer cover layer compositions, respectively, mating them to form half cups of the two layer structure, enclosing the solid core with the half cups, and effecting compression molding.

The thus formed cover of the inner and outer layers may
35 have any desired gage. Usually the inner cover layer has a
gage of 0.5 to 3.0 mm, especially 1.0 to 2.5 mm, the outer
cover layer has a gage of 0.5 to 2.5 mm, especially 1.0 to

Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	

-7-

2.3 mm, and the cover has a total gage of 1.0 to 5.5 mm, preferably 1.5 to 5.0 mm, especially 1.5 to 3.5 mm.

The multi-piece solid golf ball of the invention has a plurality of dimples formed in the outer cover layer. The
 5 dimples are formed such that when the product of the Shore D hardness of the inner cover layer multiplied by the Shore D hardness of the outer cover layer is in the range from 1,500 to 4,000, which is divided into sub-ranges, a factor V_R associated with the dimples, that is, a proportion V_R (%) of
 10 the total of the volumes of dimple spaces each defined below a plane circumscribed by the dimple edge to the overall volume of a phantom sphere given on the assumption that the golf ball surface is free of dimples has the following value.

15 (1) The product of Shore D hardnesses of inner and outer cover layers: 1,500 to less than 2,000

V_R : 0.80 to 0.95%

(2) The product of Shore D hardnesses of inner and outer cover layers: 2,000 to less than 2,500

20 V_R : 0.75 to 0.95%

(3) The product of Shore D hardnesses of inner and outer cover layers: 2,500 to less than 3,000

V_R : 0.70 to 0.95%

(4) The product of Shore D hardnesses of inner and outer
 25 cover layers: 3,000 to less than 3,500

V_R : 0.65 to 0.95%

(5) The product of Shore D hardnesses of inner and outer cover layers: 3,500 to 4,000

V_R : 0.60 to 0.90%

30 More preferred ranges of V_R are given below.

(1) The product of Shore D hardnesses of inner and outer cover layers: 1,500 to less than 2,000

V_R : 0.82 to 0.93%

(2) The product of Shore D hardnesses of inner and outer
 35 cover layers: 2,000 to less than 2,500

V_R : 0.77 to 0.93%

-8-

(3) The product of Shore D hardnesses of inner and outer cover layers: 2,500 to less than 3,000

V_R : 0.72 to 0.93%

(4) The product of Shore D hardnesses of inner and outer cover layers: 3,000 to less than 3,500

V_R : 0.67 to 0.93%

(5) The product of Shore D hardnesses of inner and outer cover layers: 3,500 to 4,000

V_R : 0.62 to 0.88%

With respect to the aforementioned range, if the value of V_R relative to the product of Shore D hardnesses deviates from the specified range, there result a prematurely falling trajectory and a reduced flight distance.

The value V_R is the sum of volumes V_p of dimple spaces defined in the golf ball surface to be described later and is calculated according to the following equation:

$$V_R = \frac{V_S}{\frac{4}{3}\pi R^3} \times 100$$

wherein V_S is the sum of the volumes V_p of dimple spaces each below a circular plane circumscribed by the dimple edge and R is a ball radius.

It is noted that V_S in the above equation is represented by the following equation and V_R can be calculated by substituting the value of V_S into the above equation of V_R .

$$V_S = N_1 V_{p_1} + N_2 V_{p_2} + \dots + N_n V_{p_n} = \sum_{i=1}^n N_i V_{p_i}$$

$V_{p_1}, V_{p_2}, \dots, V_{p_n}$ represent the volumes of dimples of different dimensions and N_1, N_2, \dots, N_n represent the number of dimples having the volumes $V_{p_1}, V_{p_2}, \dots, V_{p_n}$, respectively.

In addition to the above-mentioned requirement of V_R value, the dimples formed in the golf ball of the invention

- 9 -

must further satisfy the requirement that there are included at least three types of dimples which are different in at least one of a diameter, a depth, and a value V_0 which is the volume of one dimple space defined below a plane

5 circumscribed by the dimple edge divided by the volume of a cylinder whose bottom is the plane and whose height is the maximum depth of the dimple from the bottom. If the number of dimple types is less than 3, there arises the problem that the golf ball lofts too high or drops prematurely.

10 The value V_0 associated with the dimple requirement is described below. In the event that the planar shape of a dimple is circular, as shown in FIG. 1, a phantom sphere 2 having the ball diameter and another phantom sphere 3 having a diameter smaller by 0.16 mm than the ball diameter are
15 drawn in conjunction with a dimple 1. The circumference of the other sphere 3 intersects with the dimple 1 at a point 4. A tangent 5 at intersection 4 intersects with the phantom sphere 2 at a point 6 while a series of intersections 6 define a dimple edge 7. The dimple edge 7
20 is so defined for the reason that otherwise, the exact position of the dimple edge cannot be determined because the actual edge of the dimple 1 is rounded. The dimple edge 7 circumscribes a plane 8 (circle having a diameter D_m). Then, the dimple space 9 located below the plane 8 as shown
25 in FIGS. 2 and 3 has a volume V_p . A cylinder 11 whose bottom is the plane 8 and whose height is the maximum depth D_p of the dimple from the plane 8 has a volume V_q . The ratio V_0 of the dimple space volume V_p to the cylinder volume V_q is calculated.

30

$$V_p = \int_0^{D_m} 2\pi xy dx$$

$$V_q = \frac{\pi D_m^2 D_p}{4}$$

-10-

$$V_0 = \frac{V_p}{V_q}$$

In the event that the planar shape of a dimple is not circular, the maximum diameter or length of a dimple is determined, the plane projected shape of the dimple is assumed to be a circle having a diameter equal to this maximum diameter or length, and V_0 is calculated as above based on this assumption.

With respect to the dimples of different types according to the invention, dimples of the largest type preferably have a diameter of 3.7 to 4.5 mm, especially 3.8 to 4.3 mm and a depth of 0.15 to 0.25 mm, especially 0.155 to 0.23 mm, and their number is preferably 5 to 80%, especially 10 to 75% of the total dimple number. They are preferably set to have a V_0 value of 0.38 to 0.55. More preferably V_0 is 0.4 to 0.52.

Among the dimples of different types, dimples of the smallest type preferably have a diameter of 2.0 to 3.7 mm, especially 2.4 to 3.6 mm and a depth of 0.08 to 0.23 mm, especially 0.09 to 0.21 mm, and their number is preferably 1 to 40%, especially 2 to 30% of the total dimple number. They are preferably set to have a V_0 value of 0.38 to 0.55, especially 0.4 to 0.52.

The golf ball as a whole should preferably have a V_0 value of 0.38 to 0.55, more preferably 0.4 to 0.52, especially 0.42 to 0.5. A V_0 value of less than 0.38 is likely to lead to a non-long-lasting trajectory whereas a V_0 value of more than 0.55 is likely to lead to a high rise or aloft trajectory.

In the practice of the invention, the total number of dimples is not critical although usually 360 to 460 dimples, especially 370 to 450 dimples are formed.

The golf ball of the invention can be used as tournament golf balls and constructed in accordance with the Rules of Golf to a diameter of not less than 42.67 mm and a weight of not greater than 45.93 grams.

00541600-023000

The multi-piece solid golf ball of the invention has the advantages that various properties including spin, feeling and durability inherent to the multi-piece construction are further improved and an increased flight distance is expected due to the elimination of a high rise or dropping trajectory.

EXAMPLE

Examples of the present invention are given below
10 together with Comparative Examples by way of illustration
and not by way of limitation.

Examples and Comparative Examples

Solid cores having a diameter of 36.7 mm were prepared by mixing a rubber composition of the formulation shown in Table 1 in a roll mill and heat compression molding the composition at 155°C for 15 minutes.

Each solid core was enclosed with cover stocks shown in Table 2 in the order shown in Tables 4 and 5 to form an inner cover layer and an outer cover layer. The outer cover layer on the surface was formed with dimples shown in Tables 3, 4, and 5. Three-piece solid golf balls were obtained in this way.

The golf balls thus obtained were examined for flight distance and trajectory by the following tests. The results are shown in Tables 4 and 5.

Flight performance

Using a swing robot by True Temper Co., the ball was hit with a driver at a head speed of 48 m/sec. (#W1/HS48) to measure a spin, carry and total distance.

Trajectory

Twelve golf balls of each example were hit under the same conditions as in the flight performance test to visually observe a trajectory.

-12-

Table 1

Solid core composition (pbw)	I	II	III	IV
1,4-polybutadiene (cis structure)	100	100	100	100
Zinc acrylate	32	32	23	33
Dicumyl peroxide	1.2	1.2	1.2	1.2
Antioxidant	0.1	0.1	0.1	0.1
Zinc oxide	5	5	5	4
Barium sulfate	13.2	23.1	26.8	0
Peptizer	1	1	1	0

Table 2

Cover stock (pbw)	A	B	C	D	E	F
Hytrel 4047	100	-	-	-	-	-
Surlyn 8120	-	50	-	30	-	-
Himilan 1557	-	50	-	-	-	50
Himilan 1856	-	-	90	-	-	-
NO825J	-	-	10	-	-	-
Himilan 1605	-	-	-	20	-	50
Himilan 1706	-	-	-	50	-	-
PANDEX T-7890	-	-	-	-	100	-

- 5 Hytrel 4047: Toray duPont K.K., polyester base thermoplastic elastomer
 NO825J: Mitsui duPont K.K., ethylene/methacrylic acid/methacrylate
 terpolymer (nuclel)
 Surlyn 8120: E. I. duPont, ionomer resin
 Himilan 1557: Mitsui duPont Polychemicals K.K., ionomer resin
 10 Himilan 1856: Mitsui duPont Polychemicals K.K., ionomer resin
 Himilan 1605: Mitsui duPont Polychemicals K.K., ionomer resin
 Himilan 1706: Mitsui duPont Polychemicals K.K., ionomer resin
 PANDEX T-7890: Dai-Nihon Ink Chemical Industry K.K., thermoplastic
 polyurethane elastomer

15

Note that an appropriate amount of titanium dioxide was
 blended in resin compositions A to F.

Table 3

Type	Diameter (mm)	Depth (mm)	V ₀	Number	V _R (%)
1	4.100	0.195	0.440	32	0.89
	4.200	0.195	0.440	40	
	4.000	0.195	0.440	184	
	3.900	0.195	0.440	16	
	3.400	0.195	0.440	104	
	3.350	0.195	0.440	16	
2	4.100	0.210	0.450	32	0.86
	4.200	0.180	0.450	40	
	4.000	0.165	0.450	184	
	3.900	0.200	0.450	16	
	3.400	0.155	0.450	104	
	3.350	0.160	0.450	16	
3	3.850	0.160	0.500	288	0.80
	3.250	0.150	0.500	72	
	2.500	0.140	0.500	42	
4	3.850	0.175	0.525	288	0.93
	3.250	0.170	0.530	72	
	2.500	0.170	0.530	42	
5	4.000	0.160	0.480	114	0.77
	4.000	0.180	0.480	42	
	3.650	0.140	0.480	180	
	3.600	0.140	0.480	24	
	2.550	0.100	0.480	60	
6	3.900	0.150	0.470	240	0.66
	3.200	0.150	0.470	120	
7	3.850	0.170	0.465	340	1.04
	3.600	0.170	0.465	140	
8	3.850	0.185	0.460	340	1.12
	3.600	0.185	0.460	140	

* a distortion (mm) of the solid core under an applied load of 100 kg

Table 4

		E1	E2	E3	E4	E5
Solid core	Composition	I	II	III	IV	III
	Hardness* (mm)	3.0	3.0	4.5	2.8	4.5
	Stock	A	C	D	A	B
Inner cover layer	Shore D hardness	40	49	55	40	58
	Gage (mm)	1.5	1.5	1.5	1.5	1.5
	Stock	B	D	B	E	F
Outer cover layer	Shore D hardness	58	55	58	42	60
	Gage (mm)	1.5	1.5	1.5	1.5	1.5
	Dimple type	1	2	3	4	5
Inner layer Shore D x outer layer Shore D		2320	2695	3190	1680	3480
	V_R (%)	0.89	0.86	0.80	0.93	0.77
	#WL/HS48	2530	2540	2450	2680	2250
Trajectory	Carry (m)	225	229	228	228	227
	Total (m)	255	257	258	257	258
		somewhat rising, long-lasting, relatively low trajectory	rising, similar to balata ball	liner-like, long-lasting, medium trajectory	rising, similar to balata ball	liner-like, long-lasting, medium trajectory

Table 5

Solid core	Composition	CB1	CB2	CE3
	Hardness* (nm)	I	III	IV
Inner cover layer	Stock	3.0	4.5	2.8
	Shore D hardness	A	D	A
	Gage (mm)	40	55	40
		1.5	1.5	1.5
Outer cover layer	Stock	B	B	E
	Shore D hardness	58	58	42
Dimple type	Gage (mm)	1.5	1.5	1.5
		6	7	8
#W1/HS48	Inner layer Shore D	2320	3190	1680
	x outer layer Shore D			
	V_R (%)	0.73	1.04	1.12
	Spin (rpm)	2530	2450	2680
Trajectory	Carry (m)	220	218	217
	Total (m)	247	243	245
		liner-like, high	liner-like, low, dropping	liner-like, low, dropping

* a distortion (mm) of the solid core under an applied load of 100 kg

-16-

As seen from the results of Examples, the multi-piece solid golf balls of the invention exhibit a satisfactory trajectory and are excellent in all of spin, carry, and total flight distance.

- 5 In contrast, the multi-piece solid golf ball of Comparative Example 1 wherein V_R is below the specified range associated with the product of the Shore D hardnesses of the inner and outer cover layers was inferior in flight distance performance. The multi-piece solid golf balls of
- 10 Comparative Examples 2 and 3 wherein V_R is above the specified range was inferior in flight distance performance and exhibited a dropping trajectory.

11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000
1001
1002
1003
1004
1005
1006
1007
1008
1009
1010
1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
1021
1022
1023
1024
1025
1026
1027
1028
1029
1030
1031
1032
1033
1034
1035
1036
1037
1038
1039
1040
1041
1042
1043
1044
1045
1046
1047
1048
1049
1050
1051
1052
1053
1054
1055
1056
1057
1058
1059
1060
1061
1062
1063
1064
1065
1066
1067
1068
1069
1070
1071
1072
1073
1074
1075
1076
1077
1078
1079
1080
1081
1082
1083
1084
1085
1086
1087
1088
1089
1090
1091
1092
1093
1094
1095
1096
1097
1098
1099
1100
1101
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111
1112
1113
1114
1115
1116
1117
1118
1119
1120
1121
1122
1123
1124
1125
1126
1127
1128
1129
1130
1131
1132
1133
1134
1135
1136
1137
1138
1139
1140
1141
1142
1143
1144
1145
1146
1147
1148
1149
1150
1151
1152
1153
1154
1155
1156
1157
1158
1159
1160
1161
1162
1163
1164
1165
1166
1167
1168
1169
1170
1171
1172
1173
1174
1175
1176
1177
1178
1179
1180
1181
1182
1183
1184
1185
1186
1187
1188
1189
1190
1191
1192
1193
1194
1195
1196
1197
1198
1199
1200
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
1213
1214
1215
1216
1217
1218
1219
1220
1221
1222
1223
1224
1225
1226
1227
1228
1229
1230
1231
1232
1233
1234
1235
1236
1237
1238
1239
1240
1241
1242
1243
1244
1245
1246
1247
1248
1249
1250
1251
1252
1253
1254
1255
1256
1257
1258
1259
1260
1261
1262
1263
1264
1265
1266
1267
1268
1269
1270
1271
1272
1273
1274
1275
1276
1277
1278
1279
1280
1281
1282
1283
1284
1285
1286
1287
1288
1289
1290
1291
1292
1293
1294
1295
1296
1297
1298
1299
1300
1301
1302
1303
1304
1305
1306
1307
1308
1309
1310
1311
1312
1313
1314
1315
1316
1317
1318
1319
1320
1321
1322
1323
1324
1325
1326
1327
1328
1329
1330
1331
1332
1333
1334
1335
1336
1337
1338
1339
1340
1341
1342
1343
1344
1345
1346
1347
1348
1349
1350
1351
1352
1353
1354
1355
1356
1357
1358
1359
1360
1361
1362
1363
1364
1365
1366
1367
1368
1369
1370
1371
1372
1373
1374
1375
1376
1377
1378
1379
1380
1381
1382
1383
1384
1385
1386
1387
1388
1389
1390
1391
1392
1393
1394
1395
1396
1397
1398
1399
1400
1401
1402
1403
1404
1405
1406
1407
1408
1409
1410
1411
1412
1413
1414
1415
1416
1417
1418
1419
1420
1421
1422
1423
1424
1425
1426
1427
1428
1429
1430
1431
1432
1433
1434
1435
1436
1437
1438
1439
1440
1441
1442
1443
1444
1445
1446
1447
1448
1449
1450
1451
1452
1453
1454
1455
1456
1457
1458
1459
1460
1461
1462
1463
1464
1465
1466
1467
1468
1469
1470
1471
1472
1473
1474
1475
1476
1477
1478
1479
1480
1481
1482
1483
1484
1485
1486
1487
1488
1489
1490
1491
1492
1493
1494
1495
1496
1497
1498
1499
1500
1501
1502
1503
1504
1505
1506
1507
1508
1509
1510
1511
1512
1513
1514
1515
1516
1517
1518
1519
1520
1521
1522
1523
1524
1525
1526
1527
1528
1529
1530
1531
1532
1533
1534
1535
1536
1537
1538
1539
1540
1541
1542
1543
1544
1545
1546
1547
1548
1549
1550
1551
1552
1553
1554
1555
1556
1557
1558
1559
1560
1561
1562
1563
1564
1565
1566
1567
1568
1569
1570
1571
1572
1573
1574
1575
1576
1577
1578
1579
1580
1581
1582
1583
1584
1585
1586
1587
1588
1589
1590
1591
1592
1593
1594
1595
1596
1597
1598
1599
1600
1601
1602
1603
1604
1605
1606
1607
1608
1609
1610
1611
1612
1613
1614
1615
1616
1617
1618
1619
1620
1621
1622
1623
1624
1625
1626
1627
1628
1629
1630
1631
1632
1633
1634
1635
1636
1637
1638
1639
1640
1641
1642
1643
1644
1645
1646
1647
1648
1649
1650
1651
1652
1653
1654
1655
1656
1657
1658
1659
1660
1661
1662
1663
1664
1665
1666
1667
1668
1669
1670
1671
1672
1673
1674
1675
1676
1677
1678
1679
1680
1681
1682
1683
1684
1685
1686
1687
1688
1689
1690
1691
1692
1693
1694
1695
1696
1697
1698
1699
1700
1701
1702
1703
1704
1705
1706
1707
1708
1709
1710
1711
1712
1713
1714
1715
1716
1717
1718
1719
1720
1721
1722
1723
1724
1725
1726
1727
1728
1729
1730
1731
1732
1733
1734
1735
1736
1737
1738
1739
1740
1741
1742
1743
1744
1745
1746
1747
1748
1749
1750
1751
1752
1753
1754
1755
1756
1757
1758
1759
1760
1761
1762
1763
1764
1765
1766
1767
1768
1769
1770
1771
1772
1773
1774
1775
1776
1777
1778
1779
1780
1781
1782
1783
1784
1785
1786
1787
1788
1789
1790
1791
1792
1793
1794
1795
1796
1797
1798
1799
1800
1801
1802
1803
1804
1805
1806
1807
1808
1809
1810
1811
1812
1813
1814
1815
1816
1817
1818
1819
1820
1821
1822
1823
1824
1825
1826
1827
1828
1829
1830
1831
1832
1833
1834
1835
1836
1837
1838
1839
1840
1841
1842
1843
1844
1845
1846
1847
1848
1849
1850
1851
1852
1853
1854
1855
1856
1857
1858
1859
1860
1861
1862
1863
1864
1865
1866
1867
1868
1869
1870
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884
1885
1886
1887
1888
1889
1890
1891
1892
1893
1894
1895
1896
1897
1898
1899
1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045
2046
2047
2048
2049
2050
2051
2052
2053
2054
2055
2056
2057
2058
2059
2060
2061
2062
2063
2064
2065
2066
2067
2068
2069
2070
2071
2072
2073
2074
2075
2076
2077
2078
2079
2080
2081
2082
2083
2084
2085
2086
2087
2088
2089
2090
2091
2092
2093
2094
2095
2096
2097
2098
2099
2100
2101
2102
2103
2104
2105
2106
2107
2108
2109
2110
2111
2112
2113
2114
2115
2116
2117
2118
2119
2120
2121
2122
2123
2124
2125
2126
2127
2128
2129
2130
2131
2132
2133
2134
2135
2136
2137
2138
2139
2140
2141
2142
2143
2144
2145
2146
2147
2148
2149
2150
2151
2152
2153
2154
2155
2156
2157
2158
2159
2160
2161
2162
2163
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
2178
2179
2180
2181
2182
2183
2184
2185
2186
2187
2188
2189
2190
2191
2192
2193
2

-17-

CLAIMS:

1. A multi-piece solid golf ball comprising a solid core and a cover of two inner and outer layers surrounding the core, the outer cover layer having a surface formed with a plurality of dimples, characterized in that
- a product of the Shore D hardness of said inner cover layer multiplied by the Shore D hardness of said outer cover layer and a proportion V_R (%) of the total of the volumes of dimple spaces each defined below a plane circumscribed by the dimple edge to the overall volume of a phantom sphere given on the assumption that the golf ball surface is free of dimples satisfy any one of the following combinations (1) to (5):
- (1) the product of Shore D hardnesses of inner and outer cover layers: 1,500 to less than 2,000
 V_R : 0.80 to 0.95%
- (2) the product of Shore D hardnesses of inner and outer cover layers: 2,000 to less than 2,500
 V_R : 0.75 to 0.95%
- (3) the product of Shore D hardnesses of inner and outer cover layers: 2,500 to less than 3,000
 V_R : 0.70 to 0.95%
- (4) the product of Shore D hardnesses of inner and outer cover layers: 3,000 to less than 3,500
 V_R : 0.65 to 0.95%
- (5) the product of Shore D hardnesses of inner and outer cover layers: 3,500 to 4,000
 V_R : 0.60 to 0.90%,
- and said dimples include at least three types of dimples which are different in at least one of a diameter, a depth, and a value V_0 which is the volume of one dimple space defined below a plane circumscribed by the dimple edge divided by the volume of a cylinder whose bottom is the plane and whose height is the maximum depth of the dimple from the bottom.

- 18 -

2. The multi-piece solid golf ball of claim 1 wherein the solid core has a distortion of 2.6 to 6.5 mm under an applied load of 100 kg.
3. The multi-piece solid golf ball of claim 1 or 2 wherein both the hardnesses of the inner and outer cover layers are up to 63 in Shore D hardness.

[illegible]

-19-

ABSTRACT

A multi-piece solid golf ball is provided which is improved in spin, feeling, and durability, prevents its trajectory from rising or dropping, and offers an increased flight distance.

A multi-piece solid golf ball comprising a solid core and a cover of two inner and outer layers surrounding the core wherein the outer cover layer has a surface formed with a plurality of dimples is characterized in that a product of the Shore D hardness of the inner cover layer multiplied by the Shore D hardness of the outer cover layer and a proportion V_R (%) of the total of the volumes of dimple spaces each defined below a plane circumscribed by the dimple edge to the overall volume of a phantom sphere given on the assumption that the golf ball surface is free of dimples satisfy any one of the following combinations (1) to (5):

(1) the product of Shore D hardnesses of inner and outer cover layers: 1,500 to less than 2,000

V_R : 0.80 to 0.95%

(2) the product of Shore D hardnesses of inner and outer cover layers: 2,000 to less than 2,500

V_R : 0.75 to 0.95%

(3) the product of Shore D hardnesses of inner and outer cover layers: 2,500 to less than 3,000

V_R : 0.70 to 0.95%

(4) the product of Shore D hardnesses of inner and outer cover layers: 3,000 to less than 3,500

V_R : 0.65 to 0.95%

(5) the product of Shore D hardnesses of inner and outer cover layers: 3,500 to 4,000

V_R : 0.60 to 0.90%,

and the dimples include at least three types of dimples which are different in at least one of a diameter, a depth, and a value V_0 which is the volume of one dimple space defined below a plane circumscribed by the dimple edge

divided by the volume of a cylinder whose bottom is the plane and whose height is the maximum depth of the dimple from the bottom.

[illegible]

FIG. 1

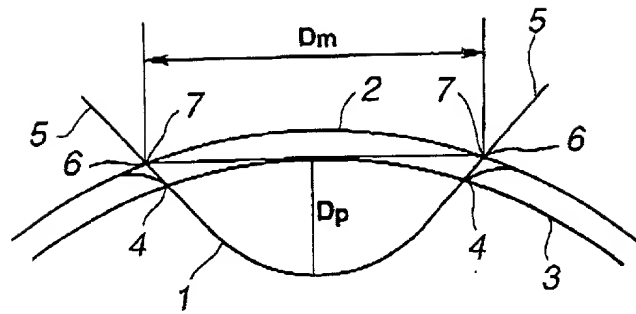
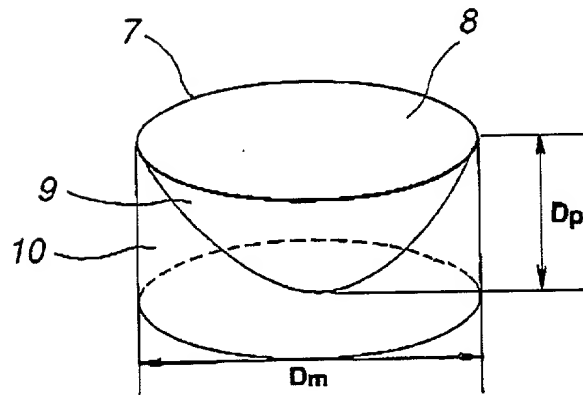


FIG.2



DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name: that I verily believe I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural names are listed below) of the subject matter claimed and for which a patent is sought in the application entitled:

Multi-Piece Solid Golf Ball

which application is:

X the attached application
(for original application)

_____ application Serial No. _____
filed _____, and amended on _____

_____ (for declaration not accompanying application)

that I have reviewed and understand the contents of the specification of the above-identified application, including the claims, as amended by any amendment referred to above; that I acknowledge my duty to disclose information of which I am aware which is material to the patentability of this application under 37 C.F.R. 1.56, that I hereby claim foreign priority benefits under Title 35, United States Code §119, §172 or §365 of any foreign application(s) for patent or inventor's certificate listed below and have also identified on said list any foreign application for patent or inventor's certificate on this invention having a filing date before that of the application on which priority is claimed:

Application Number	Country	Filing Date	Priority Claimed (yes or no)
9-228902	Japan	August 11, 1997	yes
60/058,563	U.S.A.	September 11, 1997	yes

I hereby claim the benefit of Title 35, United States Code §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in a listed prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge my duty to disclose any information material to the patentability of this application under 37 C.F.R. 1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

Application Serial No.	Filing Date	Status (patented, pending, abandoned)
09/129,883	August 6, 1998	pending

I hereby appoint John H. Mion, Reg. No. 18,879; Donald E. Zinn, Reg. No. 19,046; Thomas J. Macpeak, Reg. No. 19,292; Robert J. Seas, Jr., Reg. No. 21,092; Darryl Mexic, Reg. No. 23,063; Robert V. Sloan, Reg. No. 22,775; Peter D. Olexy, Reg. No. 24,513; J. Frank Osha, Reg. No. 24,625; Waddell A. Biggart, Reg. No. 24,861; Robert G. McMorrow, Reg. No. 19,093; Louis Gubinsky, Reg. No. 24,835; Neil B. Siegel, Reg. No. 25,200; David J. Cushing, Reg. No. 28,703; John R. Inge, Reg. No. 26,916; Joseph J. Ruch, Jr., Reg. No. 25,577; Sheldon L. Landman, Reg. No. 25,430; Richard C. Turner, Reg. No. 29,710; Howard L. Bernstein, Reg. No. 25,665; Alan J. Kasper, Reg. No. 25,426; Kenneth J. Burchfiel, Reg. No. 31,333; Gordon Kit, Reg. No. 30,764; Susan J. Mack, Reg. No. 30,951; Frank L. Bernstein, Reg. No. 31,484; Mark Boland, Reg. No. 32,197; William H. Mandir, Reg. No. 32,156; Scott M. Daniels, Reg. No. 32,562; Brian W. Hannon, Reg. No. 32,778 and Abraham J. Rosner, Reg. No. 33,276, my attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and request that all correspondence about the application be addressed to SUGHRUE, MION, ZINN, MACPEAK & SEAS, 2100 Pennsylvania Avenue, N.W., Washington, D.C. 20037-3202.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date February 7, 2000

First Inventor Hisashi YAMAGISHI

Residence Chichibu-shi

Signature Hisashi Yamagishi

Saitama-ken, Japan

Post Office Address c/o Bridgestone Sports Co., Ltd.,

Citizenship Japanese

M&D Center Chichibu, 20, Ohnohara,
Chichibu-shi, Saitama-ken, Japan

Date February 7, 2000

Residence Chichibu-shi,
Saitama-ken, Japan

Citizenship Japanese

Second Inventor Hiroshi Higuchi
First Name Middle Initial Last Name
Signature Hiroshi Higuchi
Post Office Address c/o Bridgestone Sports Co., Ltd.,
M&D Center Chichibu, 20, Ohnohara,
Chichibu-shi, Saitama-ken, Japan

Date February 7, 2000

Residence Chichibu-shi,
Saitama-ken, Japan

Citizenship Japanese

Third Inventor Junji HAYASHI
First Name Middle Initial Last Name

Signature Junji Hayashi

Post Office Address c/o Bridgestone Sports Co., Ltd.
M&D Center Chichibu, 20, Ohnohara,
Chichibu-shi, Saitama-ken, Japan

Date February 7, 2000

Residence Chichibu-shi.
Saitama-ken, Japan

Citizenship Japanese

Fourth Inventor Akira KAWATA
First Name Middle Initial Last Name

Signature Akira Kawata

Post Office Address c/o Bridgestone Sports Co., Ltd.,
M&D Center Chichibu, 20, Ohnohara,
Chichibu-shi, Saitama-ken, Japan

Date _____

Residence _____

Citizenship _____

Fifth Inventor _____
 First Name Middle Initial Last Name

Signature _____

Post Office Address _____

Date _____

Residence _____

Citizenship _____

Sixth Inventor _____
First Name Middle Initial Last Name

Signature _____

Post Office Address _____

Date _____

Residence _____

Citizenship _____

Seventh Inventor _____
 First Name Middle Initial Last Name

Signature _____

Post Office Address _____